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Analysis of Disabling Injuries Related to Roof Bolting in Underground Bituminous Coal Mines—1973

By W. K. Miller and R. R. McLellan
Health and Safety Analysis Center, Denver, Colo.

United States Department of the Interior
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Mining Enforcement and Safety Administration

UNITED STATES DEPARTMENT OF THE INTERIOR
Rogers C. B. Morton, Secretary

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James M. Day, Administrator

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ANALYSIS OF DISABLING INJURIES RELATED TO ROOF BOLTING IN UNDERGROUND BITUMINOUS COAL MINES—1973

by

W. K. Miller[1] and R. R. McLellan[2]

ABSTRACT

Roof bolter operators are exposed to two principal occupational hazards. One involves the risk of being injured by the roof bolting machine itself and the other involves the risk of being injured by a roof fall during the bolting operation. This report analyzes the various factors related to both the machinery and the roof fall hazards of roof bolting. For the calendar year 1973, the roof bolting machine and the roof bolter operator are involved in approximately 33 percent of all machinery-related and roof fall-related disabling injuries that occurred in underground bituminous coal mines making roof bolting the most hazardous job in underground coal mining. As in past years the accident trend continues to remain high for the activities of inserting the roof bolt and for drilling the roof. Roof bolter operators having less than 1 year's experience accounted for 31.4 percent of the disabling injuries related to roof bolting during 1973. The high injury rate for roof bolter operators appears to be closely related to a lack of proper and adequate training. Also, there is an obvious need to develop modifications or to redesign the current roof bolting machines.

INTRODUCTION

The purpose of this study is to investigate machinery and roof fall accidents and injuries that are commonly associated with roof bolting in underground bituminous coal mines. The study is based upon accident and injury data and information provided to the Health and Safety Analysis Center, by Coal Mine Health and Safety district offices, by coal mining companies, and by field investigations.

Although this report deals primarily with disabling injuries, attention is called to the fact that of 13 fatal injuries involving roof bolter operators during 1973, 10 were related to roof falls, 2 were related to machinery, and 1 was related to a fall of face; however, only 4 of the 10 roof bolter operators were killed while operating the roof bolting machine. The remaining six roof bolters were either setting posts, taking down loose roof, or performing other tasks related to roof bolting.

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[1] Civil Engineer, Branch of Special Studies.

[2] Chief, Branch of Special Studies.

ANALYSIS

The basic data utilized to prepare this analysis were obtained from accident and injury reports submitted to the Health and Safety Analysis Center by bituminous coal mining companies during 1973. Considering the many hundreds of accident reports on file for both machinery and roof fall disabling injuries that involve roof bolting machines, and considering that each report must be examined individually to extract details that are not in the computerized data base, a broad sampling of reports was employed. This technique permits accurate identification of the primary and contributing causes of roof bolting disabling injuries and requires a minimum expenditure of time.

The following tables analyze various factors related directly or indirectly to accidents causing disabling injuries to the roof bolter operator.

Table 1 is a comparison of all machinery and roof fall related disabling injuries, showing the percentages that involve roof bolter operators. Of 2,313 injuries during 1973, 759 or 32.9 percent involved the roof bolter operator. Three hundred and eighty-five (28.5 percent) of the machinery-related injuries and 374 (38.8 percent) of the roof fall-related injuries involved the roof bolter operator.

TABLE 1. - Disabling injuries related to the roof bolter operator, 1972-1973

Type accident	Total disabling injuries (all underground occupations)		Total disabling injuries (roof bolter operator only)		Percent injuries (roof bolter operator)	
	1972	1973	1972	1973	1972	1973
Roof fall-related.......	1,155	963	403	374	34.8	38.8
Machinery-related.......	1,419	1,350	422	385	29.7	28.5
Totals.............	2,574	2,313	825	759	32.0	32.8

Of the 2,574 injuries which occurred during 1972 as shown in table 1, 825 or 32 percent involved the roof bolter operator. Four hundred and twenty-two (29.7 percent) of the machinery-related injuries, and 403 (34.8 percent) of the roof fall-related injuries involved the roof bolter operator. The roof fall-related disabling injuries increased 4 percent during 1973 and the machinery-related disabling injuries decreased 1.2 percent during 1973.

Table 2 shows the distribution of machinery-related disabling injuries by type for underground bituminous coal mines. Equipment used underground such as scoop-trams, shuttle cars, and locomotives are charged to haulage-type accidents, and as such are not included in this study. The roof bolting machine, however, leads all others in relation to numbers of disabling injuries attributed to machinery.

TABLE 2. - Disabling injuries by machine type--1973

Machine	Injuries	Percent
Roof bolter.....................	607	36.9
Continuous miner................	313	19.0
Loading machine.................	230	14.0
Conveyor........................	169	10.3
Cutting machine.................	87	5.3
Coal drill......................	82	5.0
Longwall plow/shearer...........	66	4.0
Rock dusting machine............	33	2.0
Other...........................	58	3.5
Total......................	1,645	100.0

The roof fall and machinery-related roof bolting injuries are distributed and compared by activity, as shown in table 3. Most roof fall-related disabling injuries occur while drilling the roof (45.2 percent) and inserting the roof bolt (52.9 percent). This relationship is similar for machinery-related injuries with 33.5 percent occurring while drilling the roof and 45.9 percent occurring while inserting the bolt. Other machinery-related injuries occurred while positioning the roof bolting machine, tramming the bolting machine, and on maintenance work, as shown in table 3.

TABLE 3. - Roof bolter operator disabling injuries by activity--1973

Activity	Roof fall related (sample of 374)		Machinery related (sample of 385)		Totals	
	Injuries	Percent	Injuries	Percent	Injuries	Percent
Inserting bolt.......	198	52.9	177	45.9	375	49.4
Drilling roof........	169	45.2	129	33.5	298	39.3
Positioning bolter...	-	-	26	6.8	26	3.4
Tramming bolter......	-	-	40	10.4	40	5.3
Maintenance..........	-	-	8	2.1	8	1.0
Other................	7	1.9	5	1.3	12	1.6
Total...........	374	100.0	385	100.0	759	100.0

Table 4 shows a comparison of the parts of body injured for roof fall and machinery-related injuries. The hands and fingers are the parts of body with the highest injury rate. A cursory study of accident reports has established the fact that many of the roof bolters injure their hands by holding the drill rod with their bare hands while the drill rod is rotating. For example, in one case the roof bolter was injured because he used a wrench as an extension for his drill rod. As he started to drill the hole, the wrench flew out and hit the roof bolter operator in the head.

TABLE 4. - Roof bolter operator disabling injuries by part of body injured--1973

Part of body injured	Roof fall-related (374)		Machinery-related (385)		Totals	
	Injuries	Percent	Injuries	Percent	Injuries	Percent
Hands and fingers....	90	24.0	154	40.0	244	32.2
Multiple injuries....	67	17.9	19	4.9	86	11.3
Trunk................	52	14.0	31	8.1	83	10.9
Head and neck........	49	13.1	58	15.1	107	14.1
Arms.................	41	10.9	35	9.1	76	10.0
Feet.................	38	10.2	65	16.9	103	13.6
Legs.................	37	9.9	23	5.9	60	7.9
Total..........	374	100.0	385	100.0	759	100.0

Table 5 shows the distribution of disabling injuries that occurred at the time the roof bolter operator inserted the roof bolt. As improbable as it may seem, the highest injury rate resulted from the roof bolter bolting his hand to the roof (between the roof bolt plate and the mine roof).

TABLE 5. - Causes of disabling injuries related to inserting roof bolts--1973

Cause	Sample of 375 injuries	Percent
Mashed hands and fingers between plate and roof........	102	27.2
Operator fell down or tripped..........................	61	16.3
Bolt or plate dropped on hand or arm...................	35	9.3
Pushed wrong control lever.............................	32	8.5
Struck by wrench.......................................	31	8.3
Mashed hands and fingers lowering boom.................	30	8.0
Cuts and bruises bending bolts.........................	27	7.2
Particle in eyes.......................................	21	5.6
Drill steel broke hitting operator.....................	18	4.8
Pinched hands tightening bolts.........................	13	3.5
Broken hydraulic line--oil in face.....................	5	1.3
Total..	375	100.0

The various types of disabling injuries related to drilling the roof are shown in table 6. Rock particles getting into the eyes of the roof bolter operator leads all other accidents. This type of disabling injury is followed by the wrench slipping while changing the drill rod and then by the mashing of his fingers while changing drill steel. In many instances the operator will push the wrong control lever, injuring his hands. It appears that the roof bolting machine bucks while drilling and at times the machine is hard to control, contributing to disabling injuries.

TABLE 6. - Causes of disabling injuries to roof bolter operators while drilling the roof--1973

Cause	Injuries	Percent
Rock particles in eyes	74	24.8
Wrench slipped	53	17.8
Mashed fingers changing rod and bits	42	14.1
Pushed wrong control lever	40	13.4
Hit by flying rock fragments	27	9.1
Lowered drill head on hand	24	8.1
Operator lost balance	21	7.0
Operator holding rotating steel	17	5.7
Total	298	100.0

Types of machinery-related disabling injuries that occur while the operator is tramming the roof bolting machine are shown in table 7. This table shows that the leading cause was the victim running over his own foot, from which 14 out of 40 disabling injuries resulted. An additional 19 injuries resulted from the operator pinning himself against a post or rib and from tripping or falling. Table 7 indicates that lack of training and human error possibly are major causes of disabling injuries related to the operation of the roof bolting machine.

TABLE 7. - Causes of disabling injuries to roof bolter operators while tramming the roof bolting machine--1973

Cause	Injuries	Percent
Ran over foot	14	35.0
Pinned against post or rib	11	27.5
Operator tripped or fell	8	20.0
Caught by bolter cable	4	10.0
Pinned against loader	3	7.5
Total	40	100.0

The distribution of roof bolting disabling injuries related to operator experience is shown in table 8. In the single largest category of 238 disabling injuries (31.4 percent), the victims had less than 1 year of roof bolting experience. This table also shows that for 652 disabling injuries (85.9 percent), the roof bolter operators had less than 5 years of roof bolting experience.

TABLE 8. - Distribution of disabling injuries by roof bolter operator experience--1973

Years of roof bolting experience	Injuries	Percent
1	238	31.4
1-2	184	24.2
2-3	107	14.1
3-4	77	10.1
4-5	46	6.1
5-6	30	4.0
6-7	16	2.1
7-8	11	1.4
8-9	9	1.2
9-10	7	1.0
10	34	4.4
Total	759	100.0

CONCLUSIONS

Analysis of roof bolting injuries indicates that the roof bolter operator often is not properly or adequately trained in the use of bolting machines or of bolting techniques. The accident reports indicate that the bolting machine operator develops unsafe practices, such as working under unsupported roof and holding the drill rod while it is rotating. Often he pins his own hand against the roof while inserting or tightening the roof bolt or uses a roof bolter wrench as a drill rod extension and as a result is hit on the head by the wrench as it spins out of the head of the roof bolt machine. All too often as the roof bolter operator trams or repositions the machine, he pins himself against a rib or post. He runs over his own feet and legs with the roof bolting machine and quite often he runs into other types of mining machinery. In 1973, 13 percent of all injuries for all occupations in bituminous coal mines involved roof bolters, and 33 percent of all disabling injuries related to machinery and roof falls involved the bolting machine. These statistics indicate that roof bolting continues to be the most hazardous occupation in underground bituminous coal mining in spite of the emphasis placed upon improvement of techniques and equipment since 1969.

According to accident and injury statistics, the roof bolter operator, particularly if he has less than 1 year's experience, has a greater chance of being injured by a machine than in any other occupation, and has a considerable chance of being injured or killed by a roof fall while operating a machine. The majority of those injured had less than 2 years of roof bolting experience and were under the age of 21.

The accident and injury data and information compiled and analyzed for this report indicate the need for the following corrective actions:

1. Provide training programs to insure that the roof bolter operator is adequately trained in roof control and roof bolting practices.

2. Continue to stress the need to develop bolting machine modifications or redesign to reduce machinery hazards for the operator.

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